

**EXTREME POLYMORPHISM IN *HYPOLIMNAS BOLINA*
(LINNAEUS) (LEPIDOPTERA: NYMPHALIDAE) FEMALES FROM
A SINGLE LOCALITY ON THE SOUTHWESTERN CORAL COAST
OF VITI LEVU, FIJI**

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Abstract

A vast array of polymorphic *Hypolimnias bolina* (Linnaeus, 1758) females were collected from two sites, just 1.1 km apart, at a single, partly forested hilly locality on the southwestern Coral Coast of Viti Levu, Fiji during December 2013 and January 2014. Their polymorphism is discussed and the majority of the specimens collected are illustrated.

Introduction

Hypolimnias bolina is a sexually dimorphic species that exhibits a striking female-limited genetic colour polymorphism (Kemp and Jones 2001). Past research has largely focused on the genetics of colour variation in this species (Clark and Sheppard 1975).

The purpose of this paper is to illustrate, more fully than previously published, the extraordinary range of polymorphism seen in *H. bolina* females and also record the fact that all these forms were collected from just one small locality in Fiji. The author has researched butterflies in numerous Pacific islands, including Papua New Guinea, since 1970 but has never seen the astonishing degree of polymorphism encountered at this single locality.

A number of authors have illustrated various forms over the years. Poulton (1924) illustrated thirty-five coloured, mostly life size, polymorphic females from Fiji. Twenty of these represented dark forms and fifteen showed various brown forms. In the Plate descriptions he also referred to a variety of form names, including *euploeoides*, *murrayi*, *nerina*, *naresi*, *montrouzieri*, *pallascens*, *thomsoni* and *elliciana*. Clark and Sheppard (1975) pointed out that a considerable number of female forms of *H. bolina* had been described and the situation complicated because essentially similar phenotypes had been given different names in different geographical areas. For clarity, they chose to use the four main forms given by Poulton (1924) to describe the four basic phenotypes and gave descriptions for three groups of intermediate female forms.

The four basic female forms

(i) Form *euploeoides*: ground colour dark brown, with marginal and submarginal white spots on distal border of both fore and hind wings; these white spots can be well developed or reduced; variable blue spotting from near costal border of forewing out towards the distal margin. Some specimens show variable development of the white subapical oblique forewing bar with variable amounts of blue scaling. Immaculate black or brown *euploeoides* can also be found.

(ii) Form *naresi*: ground colour very dark brown to black, with rows of white spots bordering distal edge of both fore and hind wings; forewing with subapical white bar of usually four spots sometimes tinged with blue scales. A white patch (variable in size) in centre of hind wing may have blue scaling present; brownish scaling can replace the blue on some specimens (Fig. 22). At times a small amount of brown scaling is seen near the inner margin of the forewing in a position similar to the more extensive patch found in f. *nerina*. The apex of the forewing may also show signs of this brown scaling.

(iii) Form *nerina*: very similar to f. *naresi* regarding white markings and degree of variation but differs by having a distinctive bright orange-brown patch of scales two-thirds the way along inner margin of forewing; patch size can vary considerably. When very reduced, specimens can be difficult to separate from brown *naresi*.

(iv) Form *pallescens*: white patterns similar to forms *naresi* and *nerina* in position and variability; basal areas of forewing and particularly hind wing generally dark brown, distal areas orange-brown and variable in size and colour from dark chestnut to light yellowish; the rows of dots bordering the wings are suffused with brown.

The three main intermediate forms

(i) *euploeoides-naresi*. These vary from typical *euploeoides* with an indistinct subapical oblique white bar suffused with black and blue scales, to specimens with a well-marked bar. The light area on the hind wing is very reduced and can vary from a few scales to a roundish patch shot with blue.

(ii) *euploeoides-nerina*. The white areas are again reduced and shot with blue as in *euploeoides-naresi*. However, brown scaling can be present in the pale hindwing area in some specimens and entirely brown in others. The orange forewing patch typical of *nerina* can be large or quite reduced.

(iii) *euploeoides-pallescens*. These have the general colouration and variability as *pallescens*, but differ in that the brown scaling masks the white patches on both the fore and hind wings. Therefore the insect appears brown with lighter brown areas replacing the normally white patches.

The author found that most morphs of the 107 specimens examined could be placed within these seven groups but, given some morphs contained combinations of characters from several forms, or the characters in question showed either extreme or vestigial development, placement within a form or intermediate grouping was very difficult and therefore open to question. Two morphs in particular (Figs 8 & 50) are quite unique and difficult to place with any certainty.

Clark and Sheppard (1975) also noted the polymorphism is sex-controlled in the female of *H. bolina* and surprisingly recorded the female as being monomorphic over a large part of its range. They also cited an additional rare

Most specimens collected during the two surveys were dark forms but a small number of very light form *pallescens* were collected and also observed but were generally seen flying very rapidly, making capture impossible.

Results

Hypolimnas bolina (Linnaeus, 1758)

(Figs 1-74)

Material examined. First survey: 7 ♂♂, 96 ♀♀, FIJI : 6.5-7 km SE of Sigatoka, Coral Coast, Viti Levu, 18°10'46"S, 177°33'23"E, alt. 10 m and 18°10'31"S, 177°33'56"E, alt. 70 m, between 3.xii.2013-18.xii.2013, R.B. Lachlan. (All in RBL collection).

Second survey: 1 ♂, 11 ♀♀, same data except 31.xii.2013-21.i.2014. (All in RBL collection).

The various female forms encountered during both surveys and their numbers are recorded in Table 1. The single aberrant female of form *nerina* (Figs 73-74) is not included in this table because of its unique markings. Males (Figs 68, 71-72) varied only in extent of the white areas.

Due to the small number of females taken during the second survey, it is not possible to make a good comparative analysis of any differences between the two surveys other than to note that no forms of *euploeoides-pallescens* or *pallescens* were collected.

Specimen sizes. All measurements are set wingspans. The largest recorded were 80 mm (Figs 16 and 50); the smallest recorded was 59 mm (Fig. 51). One specimen was 60 mm (Fig. 64); four specimens (Figs 10, 24, 58) and one not illustrated had 61 mm wingspans. Approximately 21% of all females collected were noticeably smaller than average (65 mm or below), while approximately 13% were larger than average (75 mm or above).

Table 1. Combined results for *Hypolimnas bolina* females from both surveys.

Form	Numbers collected / %
<i>euploeoides</i>	23 / 21.7
<i>euploeoides-naresi</i>	11 / 10.4
<i>naresi</i>	18 / 17.0
<i>euploeoides-nerina</i>	23 / 21.7
<i>nerina</i>	15 / 14.0
<i>euploeoides-pallescens</i>	9 / 8.5
<i>pallescens</i>	7 / 6.6



Figs 1-3. *Hypolimnias bolina* female uppersides. f. *euplocoides*.



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5



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Figs 4-6. *Hypolimnna bolina* female uppersides. f. *euploeoides*.



Figs 7-9. *Hypolimnast bolina* female uppersides: (7-8) f. *euploeoides*, (8) with brown hindwing pattern similar to some f. *euploeoides-pallescentis*. (9) f. *euploeoides-naresi*.



Figs 10-12. *Hypolimnast bolina* female uppersides. f. *euploeoides-naresi*.



Figs 13-15. *Hypolimnys bolina* female uppersides: (13) *f. euploeoides-naresi*; (14-15) *f. naresi*.



Figs 16-18. *Hypolimnys bolina* female uppersides. f. *naresi*.



Figs 19-21. *Hypolimnast bolina* female uppersides. f. *naresi*.



Figs 22-24. *Hypolimnias bolina* female uppersides: (22) f. *naresi*, 'brown *naresi*'; (23-24) f. *euploeoides-nerina*.



Figs 25-27. *Hypolimnias bolina* female uppersides. f. *euploeoides-nerina*.



Figs 28-30. *Hypolimnias bolina* female uppersides. *f. euploeoides-nerina*.



Figs 31-33. *Hypolimnas bolina* female uppersides. f. *euploeoides-nerina*.



Figs 34-36. *Hypolimnias bolina* female uppersides. f. *euploeoides-nerina*.



Figs 37-39. *Hypolimnast bolina* female uppersides. *f. euploeoides-nerina*.



Figs 40-42. *Hypolimnna bolina* female uppersides. f. *nerina*.



Figs 43-45. *Hypolimnast bolina* female uppersides. f. *nerina*.



Figs 46-48. *Hypolimnast bolina* female uppersides. f. *nerina*.



Figs 49-51. *Hypolimnast bolina* female uppersides: (49) f. *nerina*; (50-51) f. *euploeoides-pallescentis*.



Figs 52-54. *Hypolimnna bolina* female uppersides. f. *euploeoides-pallesces*.



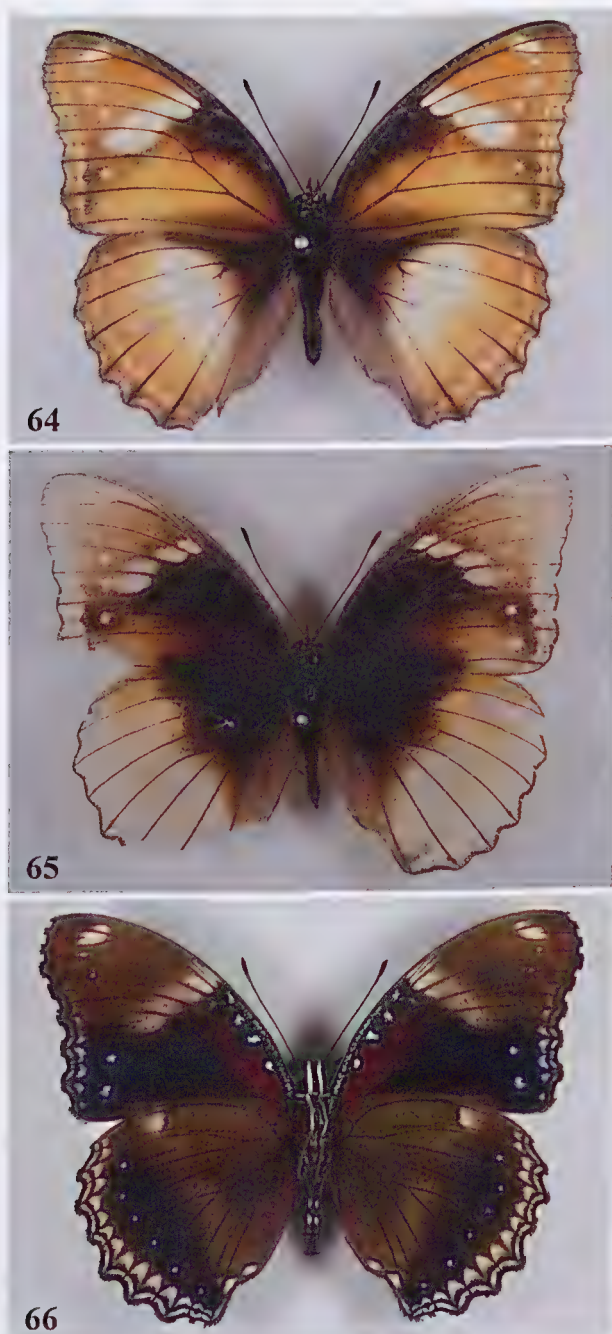
Figs 55-57. *Hypolimnastis bolina* female uppersides. f. *euploeoides-pallescentis*.



Figs 58-60. *Hypolimnias bolina* female uppersides: (58) f. *euploeoides-pallescens*; (59-60) f. *pallescens*.



Figs 61-63. *Hypolimnna bolina* female uppersides. f. *pallescens*.



Figs 64-66. *Hypolimnast bolina*: (64-65) female uppersides, f. *pallescens*; (66) male underside.



Figs 67-69. *Hypolimnast bolina* undersides: (67) female; (68) male; (69) female.



Figs 70-72. *Hypolimnast bolina*: (70) female underside of Fig. 3; (71) male upperside with reduced white areas; (72) male upperside with normal white areas.



Figs 73-74. *Hypolimnas bolina* aberrant f. *nerina* female: (73) upperside; (74) underside.

Discussion

Hypolimnas bolina is recorded from the far western Indian Ocean island of Socotra (235 km NE of the Horn of Africa) and Madagascar, through Sri Lanka and India, SE Asia, China, Malaysia, the Philippines and Indonesia to Australia, New Guinea, Solomon and Vanuatu archipelagos, New Caledonia and eastwards through the Pacific islands to (on occasions) as far east as Easter Island (Tennent 2009).

Clark and Sheppard (1975) listed 126 different localities for the four basic phenotypes and two additional intermediate forms, *euploeoides-nerina* and *euploeoides-pallescentis*, of *H. bolina* females from Madagascar in the far west of its range to Easter Island in the far eastern Pacific Ocean. It is interesting to note that they only listed Guam and two other localities, Fiji and nearby Samoa, as recording all six forms.

Clark *et al.* (1983) reported that the survey of Fiji butterflies, including *H. bolina*, conducted by H.W. Simmonds between 1921 and 1931 indicated a growing scarcity of butterflies, particularly on the main island of Viti Levu. His concern was the effect man was having on the environment of the island. However, G. and B. Johnston conducted a major survey of Viti Levu in 1980 in similar areas and found *H. bolina* to be widespread and common in places. The author agrees that, despite considerable land use on the western half of Viti Levu, *H. bolina* was found to be very common at the Coral Coast locality surveyed in December 2013 and January 2014.

Phenotypic colour variation in female *H. bolina* encompasses two primary elements, variation in the tone of the overall wing surface and variation in the shape and size of discrete colour patches. Tonal variation is seen on both dorsal and ventral wing surfaces but the tone of both surfaces varies in concert. Individuals are either relatively dark or light on both wing surfaces but never dark on one surface and light on the other (Kemp and Jones 2001). The author agrees with this observation for the most part but there are rare exceptions (see Figs 3 & 70).

Kemp and Jones (2001) discussed size plasticity and noted that dry season specimens of *H. bolina* were generally larger than wet season specimens. All the specimens illustrated here are wet season butterflies but show considerable variation in size, with a forewing length between 33 and 47 mm (set wingspans between 59 and 80 mm). In fact, the author was surprised by the large size of some females clearly observed at the two survey sites.

Kemp and Jones (2001) also noted seasonal colour variation, with wet season butterflies being lighter and brighter on both wing surfaces than dry season specimens. The author, in fact, found that the majority of *H. bolina* females collected or observed at the survey sites in December 2013 were dark or darkish.

Most authors who have previously illustrated colour pictures or photographs of *H. bolina* females have shown a variety of forms but often from different localities in the one country or different countries, not necessarily in the same region of the world. In this paper all female specimens illustrated (Figs 1-65, 73), in all their forms, were collected from just two small sites only 1.1 km apart – within easy walking distance. This clearly indicates that an astonishing degree of polymorphism in *H. bolina* females is currently occurring in parts of Fiji, perhaps not seen anywhere else in its entire range.

Vane-Wright *et al.* (1977) even went so far as to suggest that the females of *H. bolina* were so variable in some areas that it was doubtful if it should be classed as a truly polymorphic species, with respect to the female, as the variation was quasi-continuous.

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